# Utilizing Benthic Mapping and 3D GIS to assess Atlantic Sturgeon Habitat and the viability of Beach Replenishment Resources in the Delaware River and Bay


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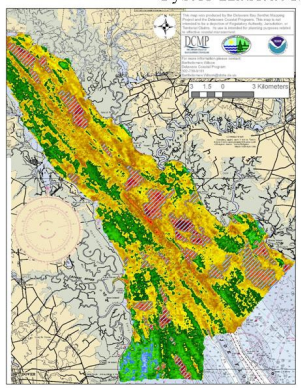
It has become imperative for coastal managers to better understand the resources and the interrelationships of the components within the coastal ecosystems. Through an integrated program by the Coastal Program of Delaware's Division of Soil and Water Conservation (DNREC), the University of Delaware, and Delaware State University, a benthic and sub-bottom imaging project to identify and map the benthic habitat and sub-bottom sediments of Delaware Bay and River was initiated.

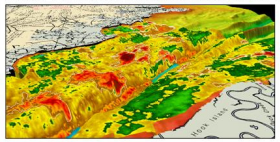
This project has resulted in many major milestones, which included: mapping over 350 square miles, identify the spatial extent and relative density of the oyster and corbicula beds, facilitate a greater understanding of the local and regional sediment distribution patterns and pathways, and locate keys habitats for several charismatic species. Most importantly integrating the bottom and sub-bottom sediment with species tracking information, in a 3D GIS environment, have enable a new opportunity to assess the habitat relationship between Atlantic Sturgeon and several key regions in the Delaware River.

The 3D GIS integration has also allowed for sand replenishment borrow sites to be identified, based upon sediment grain sizes and volumetric requirements, and subsequently delineated to areas that would minimize the potential devastating effects upon EFH and potential Sabellaria vulgaris habitat.

## Oyster Habitat Mapping




**Middle, Ship John, Shell Rock, and Bennies Oyster Beds**



New Jersey
- 25 Beds Located
- Total Area of Shell:
  - 13.4 Square miles
  - 8,601 Acres

Delaware
- 15 Beds Located
- Total Area of Shell:
  - 2.9 Square miles
  - 1,835 Acres

A total of 40 oyster beds have been located through the mapping project, for a total area of 16.3 square miles. The project has also help resource managers gain a better understand of the relationship of shell placement (both through natural production and restoration planting efforts) to oyster bed viability and longevity. The oyster beds that line the New Jersey side of the main channel (pictured above; Middle, Ship John, Shell Rock, and Bennies) are experiencing extensive transport of oyster shell down the main channel slope (through sliding) due to the proximity of a higher current velocity zone. The shell is transported into the channel where it is lost from the oyster spats ability to become potential new habitat.

Technologies used in the Benthic Mapping project:

- RoxAnn Seabed Classification System
- Chirp Sub-bottom Profiler
- Multibeam bathymetry system
- Field Verification
  - Ponar sediment grab samples
  - Vibra-coring
  - Push-coring
  - Underwater Video

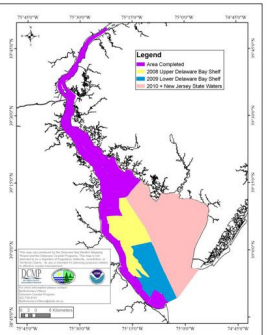
**Partners in Mapping The Delaware Bay and River**

- University of Delaware Geosciences Department
- Delaware Fisheries
- Delaware Shoreline and Waterway Division
- New Jersey Shellfish Bureau
- Delaware State University
- Haskin Shellfish Research Laboratory, Rutgers
- Partnership for the Delaware Estuary
- New Jersey Department of Environmental Protection (Coastal Management Office)
- Office of Ocean and Coastal Resource Management, National Oceanic and Atmospheric
- Administration under award numbers NA17OR1243, NA04NOS419003,NA04NOS4190034, NA03NOS4200133, and NA04NCS4200072.

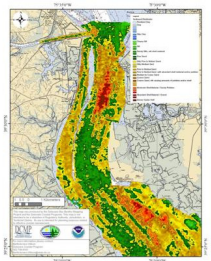
**Delaware River & Bay**
755.2 sq. miles
380.6 (DE)
374.6 (NJ)

**Area Mapped as of 2007**
41 % Bay & River
290 square miles
56 % DE
208 square miles

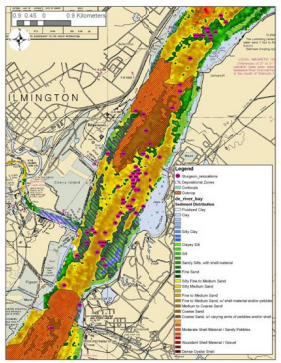
**Area Mapped by End of 2008 Field Season**
79 % DE
300 sqmiles
51 % Bay & River:
380 square miles



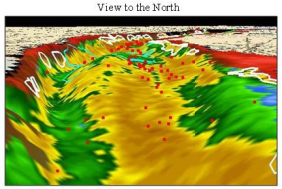

## Atlantic Sturgeon Habitat Mapping



Grab samples from the channel (pictured above to right) revealed a highly compacted dewatered silty fine to fine sandy silt (with Glauconite). These areas were later revealed, through geologic interpretation, to be areas of Cretaceous sediment outcropping.



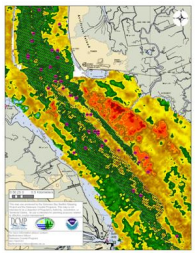

View to the North



Sturgeon tracking data show that they prefer to inhabit the eastern side of the Cherry Island flats , which are characterized by extensive course reworked sediments, away from the main navigation channel (to the west side of Cherry Island Flats) and the depositional zones at the mouth of the Christina River and adjacent to the Edgemoor power station and DuPont facility.

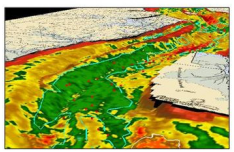
Example of fluidized clays and silts from the Christiana River depositional zone.

Example of poorly sorted course sediments that thinly cover or lye upon the Cretaceous outcropping

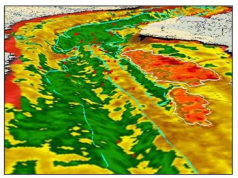


Juvenile Sturgeon acoustic tracking data (manual relocation, marked with purple and red dots) tend to correlate with the areas of Cretaceous sediment exposure or near surface exposure, outlined in blue or black hatching.

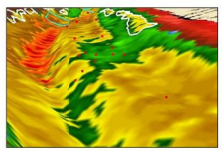
View to the Northeast



View to the North

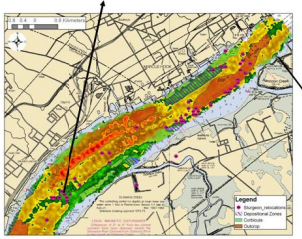


View to the North

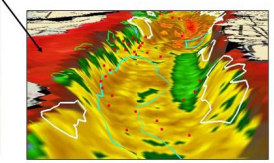


Asiatic Clam (*Corbicula fluminea*)

Several areas of focus include Marcus Hook where denser congregations of sturgeon are adjacent to dense beds of Asiatic Clam (*Corbicula fluminea*), which are very productive and areas of higher biodiversity, and areas of Cretaceous outcropping. Outcropping areas are also associated with having a very poorly sorted course sediment cover (fine sand to cobble).

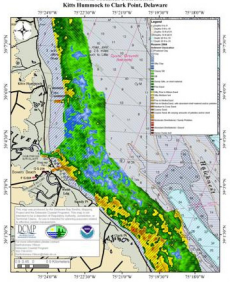


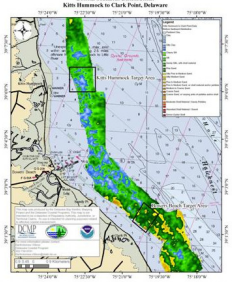

View to the South



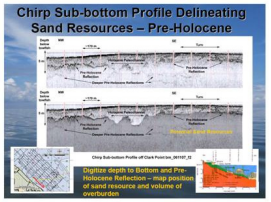
## Locating Beach Replenishment Resources

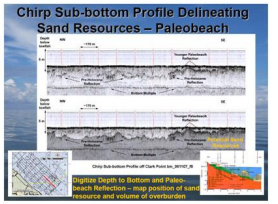
The Delaware Coastal Program and Shoreline and Waterways Section of DNREC have setout
To develop a method of location potential borrow sites for beach replenishment that not only satisfy the Volumetric and grain size requirements needed for the project but also have been sighed in areas that will Minimize the impact upon essential fish habitat (EFH) and other areas of high biodiversity.




For the Kitts Hummock and Bowers Beach replenishment projects the potential Borrow sites needed to have a minimum depth of 6 ft MLW (due to dredge limitations). The study areas was then minimized to meet these requirements, which also allowed the potential borrow areas to migrate further from areas that were determined to be areas of potential Sabellaria vulgaris habitat (a sand building tubeworm considered to be EFH; areas that are red to brown on the maps to the left). This aided in meeting the projects goal.



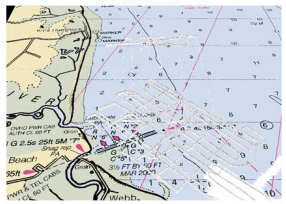



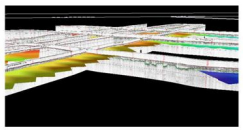

Potential Sand resources are usually located ty cores taken of the benthic and sub-bottom sediments, but now geophysical methods are now being more commonly incorporated. Unfortunately, chirp sub-bottom profiles or seismic profiles (shown to the right; chirp lines are from Clark Point Borrow site) usually are limited because they are viewed in 2D and then the potential layers or sediments of interest are then projected to the next survey line through proxy 3D fence diagrams(images placed in a 2D environment with different distance perspectives to derive a 3D like view). These methods cannot be manipulated or easily altered to change scales and views. This leads to un-certainties in the true spatial extent and trend of the sediment of interest. Thereby introducing potential miscalculations of volume, overburden, depth, and placement.

Utilizing 3D fence Diagrams, within a GIS esvironment, has enabled the chirp data to be processed and interpreted with a continuous mind set, which enables the sedimentary and stratigraphic environments analysis to incorporate the environmental continuums and transitions, which are usually unable to be determined or expressed.

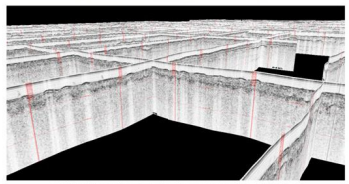
Examples of the 3D fence diagram structure for Bowers Beach are shown below (the 3D layers and sediment block models are not shown due core data is still being collected and processed).

View to the North

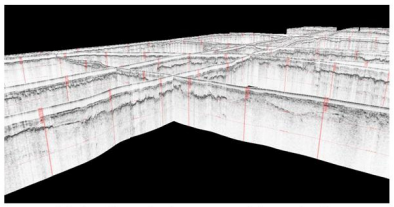




A chirp fence diagram with a 3D layer plane



A chirp fence diagram showing an area containing fine grained organic rich 2 meter thick sediment deposit.



A chirp fence diagram showing an area containing a sandy sediment deposit, approximately 1 to 3 meters thick.